Effects of Music Interventions on Maternal and Child Outcomes in Obstetric Settings: An Updated Systematic Review and Meta-Analysis

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Abstract: ***Introduction***: Pregnancy and childbirth are highly challenging, as it is an event of significant psychological, social and emotional change for women that may predispose them to stress and anxiety. Music therapy is emerging with increasing popularity as an additional treatment for ameliorating stress, anxiety and labor pain. This study aimed to examine the effect of music interventions on maternal perinatal mental health and childbirth outcomes to establish comprehensive evidence for clinical decision-making. ***Methods***: This study is a systematic review and meta-analysis. ***Results***: Twenty-six randomized controlled trials (RCTs) involving 3,969 women included in this review. The overall effects indicated that anxiety levels in women in the music group were significantly lower than in the usual care group (SMD =-4.17, 95% CI: -5.13 to -3.20). The pooled results also indicate that music interventions could significantly reduce depressive symptoms (SMD =-2.66, 95% CI: -4.98 to -0.34). The music interventions also tended to reduce women's stress, but without significantly statistical differences (Z=1.84, P=0.07). Eight studies reported the effects of music interventions on the physical outcomes of pain and blood pressure and pain. Music interventions could significantly reduce pain intensity (SMD =-1.43, 95% CI: -2.67 to -0.18, blood pressure: systolic BP (SMD =-2.23, 95% CI: -3.76 to -0.70), and diastolic BP (SMD =-1.80, 95% CI: -3.00 to -0.61), and reduced heart rate vital signs (SMD =-3.33, 95% CI: -4.36 to -2.30). Five studies reported the effects of music interventions on women's satisfaction and quality of life, and found that music interventions significantly improved these outcomes (SMD =2.86, 95% CI: 1.66 to 4.05). In terms of child outcomes, the music interventions positively stimulated fetal movement (SMD =1.62, 95% CI: 0.05 to 3.19) and accelerations (SMD =1.08, 95% CI: 0.74 to 1.42). ***Conclusions***: These results suggest that music interventions may have the potential to reduce obstetrical complications, so that application of music interventions across all three trimesters and during labor may be advisable in routine obstetric practice.

INTRODUCTION

Pregnancy and childbirth are highly challenging, as it is an event of significant psychological, social and emotional change for women that may predispose them to stress and anxiety [1-4]. Increased levels of stress and anxiety can lead to negative effects on both maternal and child outcomes [4]: Antenatal anxiety and depression can result in increased maternal preterm birth rates and low birth weight [5-7]. High levels of anxiety in women during labour and in women undergoing Caesarean section (CS) may result in higher infection risk, elevated blood pressure and heart rates, increased cortisol levels and slower wound healing [8-10]. Moreover, high levels of anxiety can also lead to increased analgesic consumption in women undergoing CS, who may also experience higher levels of post-Caesarean pain [8].

The prevalence of anxiety symptoms in pregnancy across all three trimesters is up to 22.9% [11], with 17.8% of women experiencing significant anxiety symptoms in the first four weeks following childbirth [11]. In addition, the prevalence of postpartum depression symptoms of women ranges from 10% to 20% [12]. Hence, this suggests that both anxiety and depressive symptoms pose a leading public health issue due to the negative effects on both maternal and child outcomes [11,13]. In consequence, interventions for reducing perinatal mental health problems in women are of paramount importance.

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Pharmacological interventions for perinatal anxiety and depressive symptoms have negative complications in terms of both maternal and child outcomes [4]: Benzodiazepines and most antidepressants can cross the placental barrier, and are associated with preterm labour and low birth weight in newborns [14-16]. Compared with no exposure to pharmacological treatment, women exposed to relaxants and antidepressants before the 16th week of pregnancy have a three-fold increased risk of preeclampsia [14,17]. Therefore, establishing complementary and alternative medicine (CAM) therapies for pregnant women is necessary.

Music therapy as a nonpharmacological intervention has received increased interest in the healthcare literature, and music intervention is emerging with increasing popularity as an additional treatment in routine obstetric nursing practices [3,18]. For example, music is a promising CAM intervention employed to ameliorate labour pain, as music intervention is one of the safest and easiest therapies to administer in a healthcare setting [19]. In addition, music intervention may be a good CAM option to resolve mental health problems, as it requires simple technical expertise, and music is an easily accessible, cost-effective and highly acceptable intervention [1,4]. Recent systematic reviews have shown that music-based interventions may reduce perinatal mental health issues during pregnancy [1,2], labour [10] and postpartum [20]. Nevertheless, few published studies are known to have been conducted on the effects of music interventions on maternal perinatal mental health and labour pain during pregnancy, labour and the postnatal period.

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While several systematic reviews have evaluated the effect of music on the mental health outcomes of pregnant women, very few randomized controlled trials were included in the meta-analysis [e.g. 1]. Recently, there has been an increasing number of RCTs examining the effects of music interventions on pregnant women. Therefore, the aim of this updated meta-analysis was to examine the effect of music interventions on maternal perinatal mental health and childbirth outcomes, in order to establish comprehensive evidence for clinical decision-making.

METHODS

Search strategies

A literature search was conducted of PubMed, CINAHL, the Cochrane Library, and CNKI between January 2011 to July 2020. Search terms included music or music therapy, women during pregnancy, labour stage or postpartum stages. Similar searching terms were conducted in the Chinese electronic database of CNKI: yinyue (音乐) OR yinyueliaofa (音乐疗法); huaiyun (怀孕) OR shengchan (生产) OR chanhou (产后). There were limitations in the publications searched, which included only publications in the English and Chinese languages. Detailed search strategies are listed in Appendix 1.

Inclusion and Exclusion Criteria

The criteria of the studies that were included were guided by the PICOs guideline:

P (Participants): Participant eligibility criteria were limited to adult women (18 years old and above), who were in the pregnancy, labor or postpartum stage. The review aimed to include either nulliparous or multiparous women.

I (Interventions): music or music experiences were the primary intervention modality. Music was not a primary intervention modality (i.e. bundled interventions where music was not an essential component).

C (Comparators): usual care, or other active interventions.

O (Outcomes): maternal and child outcomes.

S (Studies): eligible studies were randomized controlled trials (RCTs). Observational and other types of studies were excluded in this meta-analysis.

Data Extraction

Two research nurses independently helped to review and select trials based on the above criteria. If any inconsistency occurred, a third investigator would initiate an online discussion meeting in order to come to a consensus. Each RCT that was included was appraised for quality and methodological rigor, based on the Cochrane risk-of-bias tool for assessing the following domains: “allocation concealment, randomization sequence, participant blinding, specialist outcome blinding, other biases, incomplete data and selective report” [21].

Data Synthesis

All statistical analyses were conducted using RevMan (Review Manager) [Computer program], Version 5.4. Copenhagen: The Nordic Cochrane Centre [22]. Continuous data were expressed as mean differences (MD) with a 95% confidence interval (CI) or as standardized mean differences (SMD) if the outcomes were conceptually the same in the different studies, but measured in different ways. When the mean or standard deviation (SD) value was unavailable, the median value was adopted for the meta-analysis instead, and the SD would be input from the CI or p values based on the guidance of the Cochrane Handbook for Systematic Reviews of Intervention [21]. The I2 statistics were calculated to evaluate heterogeneity. Publication bias of these included studies was planned to use funnel plots, if 10 or more studies were included in the meta-analysis.

RESULTS

Study Selection and Description

The literature searching diagram is listed in Figure 1. Of 830 searched records, a total of 26 eligible RCTs [23-48] was included in this meta-analysis. The key characteristics of these studies are summarized in Table 1.

Study Methodological Quality

Overall, a majority of the studies that were included had a methodological quality that was moderate to weak (Figure 2a). The quality assessment indicates that the third domain of performance bias (blinding of participants and personnel) was at high risk of bias due to the nature of the intervention, which could not be blinded. Of the 26 RCTs that were included, four [30, 32, 36, 44] had a high risk of bias assessed by the Cochrane assessment tool (Figure 2b).

Of 26 RCTs, 21 [23-28, 30-37, 39-41, 43, 45-48] compared the effects of music intervention with usual care on women’s health outcomes across the antenatal, labor and postnatal periods. Four studies incorporated a three-arm design, besides using music intervention and usual care groups, with an additional group of dance, massage or acupressure intervention [29, 38, 42]. One study compared music intervention with a combined intervention incorporating music and acupressure [44].

Effects of Music Intervention Versus Usual Care on Maternal and Fetal Outcomes

To examine the effects of music interventions on the outcomes of anxiety, this meta-analysis pooled 18 studies and found that the anxiety levels of women in the music group were significantly lower than those in the usual care group (SMD =-4.17, 95% CI: -5.13 to – 3.20) (Figure 3).

Table 1: Characteristics of included randomized controlled trials (N=26).

Author & Year	Country	Sample	Intervention	Outcome measures	Main findings
Kafali et al. (2011) [23].	Turkey.	201 low-risk pregnant women with mean age of 27.1 years.	Patient's own music or chosen from three types of recorded files during nonstress test.	STAI, Fetal Heart Rate, fetal movement.	Significantly lower posttest STAI in the music group than in the control group (p<0.001).
Kushnir et al. (2012) [24].	Israel.	60 low-risk pregnant women, undergoing an elective cesarean delivery.	Patient-preferred music (light classical music or Israeli tunes) were played for 40 min, using a Discman with earphones, while lying on their beds before operation.	Mood states scale, Perceived threat of surgery scale, blood pressure, HR, RR.	Significant incr00ease in positive emotions and a significant decline in negative emotions and perceived threat of the situation. Significant reduction in SBP, increase in DBP and RR.
Li & Dong (2012) [25].	China.	60 low-risk pregnant women, undergoing elective cesarean delivery.	Self-chosen Chinese classical music was played for 30 min before operation and was continued after anesthesia.	SAS, total power, LF, HF, and LF/HF ratio in HRV (at the preoperative visit and just before operation).	The mean HRV was significantly less, the mean HF value was significantly increased, and the mean anxiety score was significantly decreased.
Simavli et al. 2014a [26].	Turkey.	132 low-risk primigravid women, singleton, expected to have NSD.	Self-selected music (relaxing, regular rhythmic patterns) were played all the time with 20-min break for every h via headphones since two cm cervical dilatation to first 2 h of the active phase.	VAS-A, SBP, DBP, HR (before music, latent phase, active phase, second stage and 2 h postpartum).	A significantly lower level of anxiety ($p < 0.001$), maternal hemodynamics and fetal HR ($p < 0.01$) in the interventional group at all stages of labor and analgesic requirement postpartum ($p < 0.001$).
Simavli et al. 2014b [27].	Turkey.	141 low-risk primigravid women, singleton, expected to have NSD.	Self-selected music (relaxing, regular rhythmic) played all the time with a 20-min break for every 2 h since two cm cervical dilatation to the end of the third stage.	VAS for pain intensity, anxiety and satisfaction; EPDS for depression .	Mothers in the music therapy group had a lower level of postpartum pain and anxiety than the usual care group; the two groups in terms of satisfaction rate ($p < 0.001$) and postpartum depression rate at postpartum ($p < 0.05$).
Chang et al. (2015) [28].	Taiwan.	296 women, aged between 24 and 41 years., gestational age ≥ 17 weeks at medically low risk of pregnancy.	Five types of music to choose from: crystal music, nature sounds, classical music, lullabies and symphonic music.	PSS, and PSRS.	Music listening did not significantly reduce stress scores; while pregnancy specific stress was significantly reduced by music.
Dehcheshmehi & afiei (2015) [29].	Iran.	90 primiparous women. 30 each in the music therapy group, Hoku point ice massage group, and usual labor care group.	Music therapy versus Hoku point ice massage.	VAS.	Mean pain scores were significantly lower at all of the time points in the music therapy group and the Hoku point ice massage group than the control group ($p < 0.05$). The pain scores showed a more decreasing trend after the intervention in music therapy group than that in the Hoku point ice massage group.

Continued

Zhang (2015) [30].	China.	150 Chinese primipara during vaginal birth.	Music therapy with psychological intervention versus usual care.	HAM-A, HAM-D, duration of delivery, childbirth outcomes such as Apgar score.	Music therapy combined with psychological interventions can help shorten the birthing process, improve childbirth outcomes, and ease negative emotions and stress.
Cao et al. (2016) [31].	China.	60 women, mean age 29.6 years, admitted with pregnancy-induced hypertension.	Patient's own music or chosen from a recorded CD.	HAM-A, HAM-D, SF-36 scale, maternal BP, serum angiotensin II level.	Significantly lower posttest HAM-A in the music group (15.4 ± 3.6) than in the control group (20.3 ± 3.6), ($p < 0.05$).
Liu et al. (2016) [32].	Taiwan.	121 women, over 18 years, gestation: 18-34 weeks with poor sleep quality.	Patient's own music or chosen from five types of recorded CD, at least 30 min a day at bedtime at home for 2 weeks.	S-STAI, PSQI, PSS.	Significantly lower posttest S-STAI in the music group (37.3 ± 10.0) than in the control group (42.1 ± 11.6), ($p < 0.05$).
Oh et al. (2016) [33].	South Korea.	60 Korean pregnant women within 28 to 40 gestational weeks.	Music intervention was provided to pregnant women in the experimental group during NST.	STAI, fetal heart rate (FHR) pattern, frequency of acceleration in FHR, fetal movement test.	The music therapy group showed significantly lower scores in state anxiety than the control group. Frequency of acceleration in FHR was significantly increased in the music intervention group.
Shivamurthy & Anusha (2016) [34].	India.	100 primigravida women in active labor. 50 each in experimental and control group.	Music therapy on serum cortisol in primigravida in active labor.	Serum cortisol in blood sample.	The group differences after the music therapy sessions indicated that the music group had significant lower serum cortisol levels compared to the control group ($p < .05$).
Karkal et al. (2017) [35].	India.	60 primigravid women who were in the active phase of labor.	Music was administered in the first stage of labor.	SAS.	The mean score of anxiety between the music and control groups was significantly ($p < 0.001$).
Nwebube et al. (2017) [36].	United Kingdom.	36 women, over 18 years, recruited online.	Recorded files by investigator, at least 20 min a day for 12 weeks at home.	S-STAI, EPDS.	Significantly reduced S-STAI after the intervention (30.3 ± 8.9) than at baseline (37.1 ± 12.1), ($p = 0.02$).
Toker & Kömürcü (2017) [37].	Turkey.	70 women, mean age 30.6 years, gestation over 30 weeks, admitted with pre-eclampsia.	Chosen by patient from recorded playlists, receiving music for 30 min a day for 7 days.	S-STAI, Newcastle Satisfaction with Nursing Scale, maternal HR, fetal movement, FHR.	No significant difference in posttest S-STAI between the groups (music group 43.9 ± 4.7 vs control group 42.3 ± 7.6), ($p = 0.32$).
Choubsaz et al. (2018) [38].	Iran.	60 low-risk pregnant women, ASA class I and II undergoing elective cesarean delivery.	The "Motivation" piece, a sedative musical piece, was played through a headphone during the surgery.	STAI before and after operation.	Significant differences between STAI in music (21.83 ± 11.9 vs. 13 ± 8.02) and control groups (24.4 ± 11.89 vs. 16.6 ± 8.14) pre and post-test ($p = 0.001$).

Continued

Garcia-Gonzalez et al. (2018) [39].	Spain.	409 primiparous women, mean age 31.4 years, third trimester of pregnancy, medically low risks.	Recorded CD by investigator, receiving music at home (40 min per session, 14 sessions, 3 times/week).	S-STAI, birthing process, newborn parameters.	Significantly lower posttest S-STAI in the music group (12.8 ± 6.8) than in the control group (21.0 ± 8.0), (p < 0.001).
Gokyildiz Surucu et al. (2018) [40].	Turkey.	50 low-risk primigravid women.	Music was played in Acemasiran mode with earplugs for 3 h (20 min of listening with 10-min breaks) during the active phase.	STAI, RR, HR, SBP, DBP, dilatation, effacement, fetal HR, period of contraction and frequency.	The women who listened to music during labor had lower anxiety levels, evaluated the labor as easier, had longer periods of contraction, and their labor progressed faster.
Hepp et al. (2018) [41].	Germany.	304 low-risk pregnant women undergoing primary cesarean delivery.	Slow tempo music from one (15 tracks) of four self -selected genres via loudspeakers started when entering the operating room.	VAS-A, STAI, salivary cortisol and salivary alpha amylase at admission, skin suture, and 2 h after operation; HR, SBP and DBP at skin incision.	At skin suture, significantly lower STAI (p = 0.004) and VAS-A (p = 0 .018). 2 h after OP, lower VAS-A (p = 0.018); salivary cortisol increased from admission to skin suture (p = 0.043); lower SBP (p = 0.002) and HR (p = 0.049) at skin incision.
Wan & Wen (2018) [42].	China.	119 low-risk primigravid women, singleton, and expected to have NSD.	Relaxing, soft and regular rhythmic music recommended to participants was played with a 20-min break for every 2 h during the active phase.	VAS.	VAS-A scores significantly different from those in the controls at all-time points (all ps < 0.05).
Drzymalski et al. (2019) [43].	United Sates.	150 parturients undergoing elective cesarean delivery.	Music therapies include patient-selected music (Pandora), and pre-selected music (Mozart) versus no music as control.	NRS for measuring anxiety and pain.	Postoperative anxiety did not differ in both music groups compared with the control group. Postoperative pain was not different in the Pandora group vs. control group, but was lower in the Mozart vs. control group (p=0.03).
Liu et al. (2019) [44].	China.	1000 Chinese primigravid women undergoing elective cesarean delivery.	Music therapy with auricular-point pressure before perioperative at 1h and postoperative at 3h, 6h, 12h and 24 h for one hour's intervention.	SAS, VAS, cortisol level.	Women in the music therapy with acupressure intervention reported lower levels of anxiety, pain scores and lower levels of cortisol, compared with women in the usual care group.
Teckenberg-Jansson et al. (2019) [45].	Finland.	102 women, mean age 31 years, admitted with pregnancy-related complications.	Playing of two lyre instruments and humming at bedside by the music therapist, 30 min a day for 3 days.	S-STAI, PSS, FHR variability.	Significantly more improved anxiety level in the music group than in the control group, (p = 0.02).
Buglione et al. (2020) [46].	Italy.	30 nulliparous women in spontaneous labor with singleton pregnancies and vertex presentation.	Music intervention delivered by listening to music via speakers until the delivery of the baby, women could select the songs at their discretion.	VAS for anxiety and pain.	Women in the music intervention group reported lower anxiety pain levels than women in the usual care group.

Continued

Gönenç et al. (2020) [47].	Turkey.	93 nulliparous in the active phase of labor at term gestation with single fetuses.	Music intervention (pop music, or Turkish folk music, or religious music) alone, music combined with dance intervention versus, usual care.	VAS, Delivery Expectancy/Experience Questionnaire to measure fear.	Women in the music intervention or music combined dance groups reported significantly lower pain and fear than nulliparous women in the usual care group of labor (ps<0.05).
Yüksekol et al. (2020) [48]	Turkey.	60 pregnant women hospitalized due to mild preeclampsia.	Music intervention delivered by listening to music only for 30 min at a specific time in the morning and evening in a given day.	BP, STAI.	Women in the music group reported lower anxiety score, and a significant reduction in diastolic blood pressure in the evening than women in the control group (ps<0.05).

Abbreviations: BP, blood pressure; EPDS, Edinburgh Postnatal Depression Scale; FHR, fetal heart rate; h, hours; HAM-A, Hamilton Anxiety Scale; HAM-D, Hamilton Depression Rating Scale; HR, heart rate; HRV, heart rate variance; NRS, Numeric Rating Scale; NST, Non-Stress Test; PSQI, Pittsburgh Sleep Quality Index; PSRS: Pregnancy Stress Rating Scale; PSS: Perceived Stress Scale; RR, respiratory rate; SAS, Self-Rating Anxiety; SF-36, Short-form health survey; S-STAI, State Scale of the State-Trait Anxiety Inventory; STAI, State-Trait Anxiety Inventory; VAS, Visual Analog Scale.

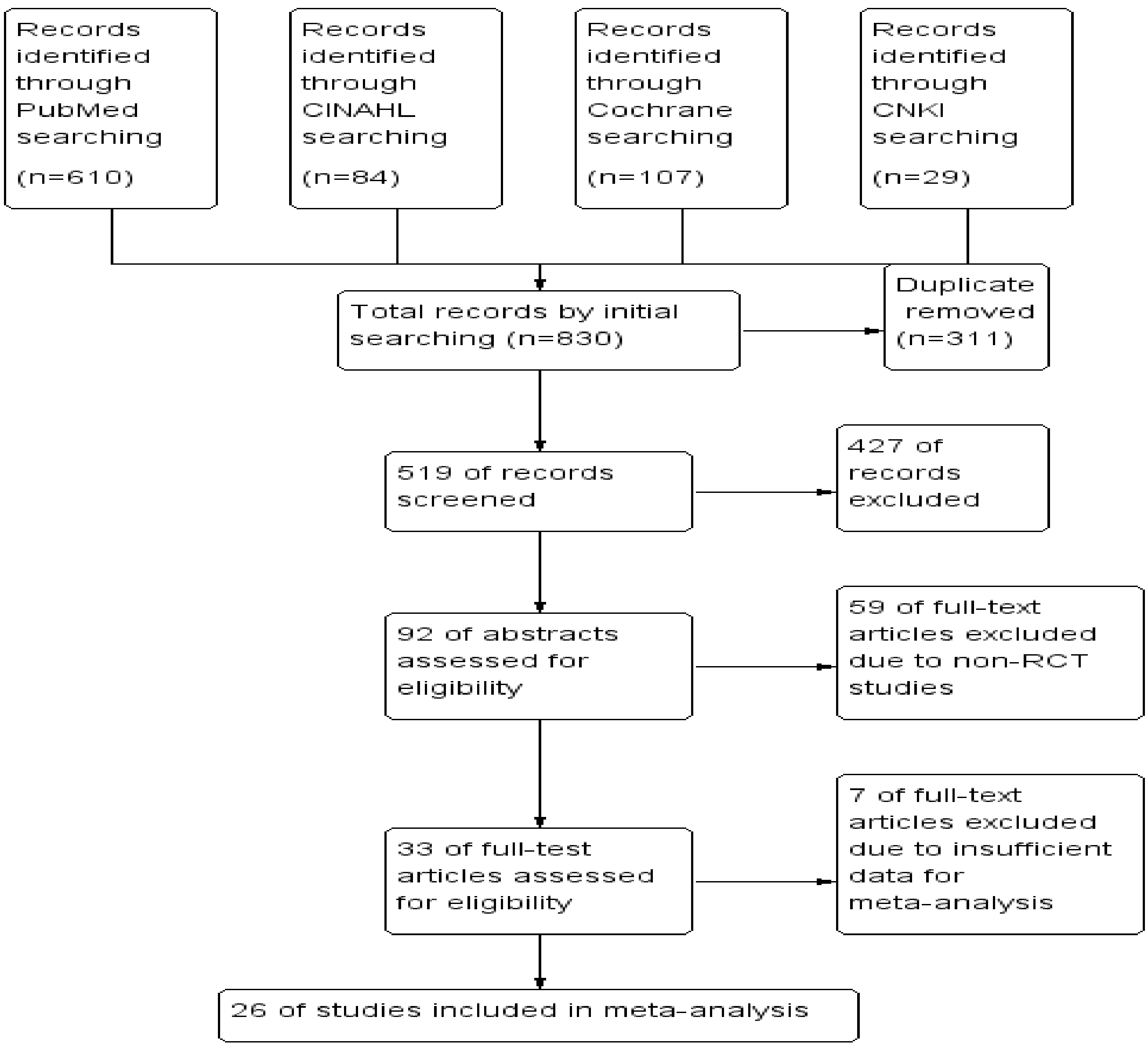

Figure 1: PRISMA Study Flow diagram. CINAHL, Cumulative Index to Nursing and Allied Health Literature; CNKI, China National Knowledge Infrastructure.

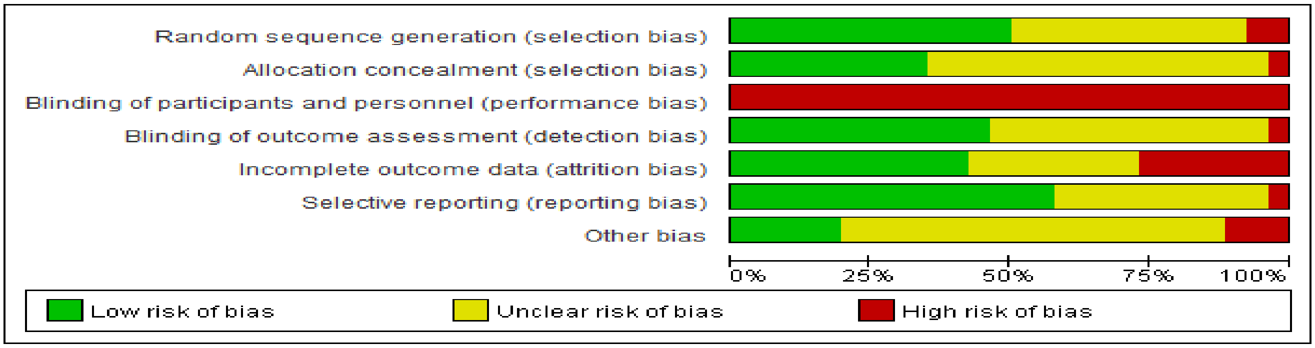

Figure 2(a): Risk of bias graph.

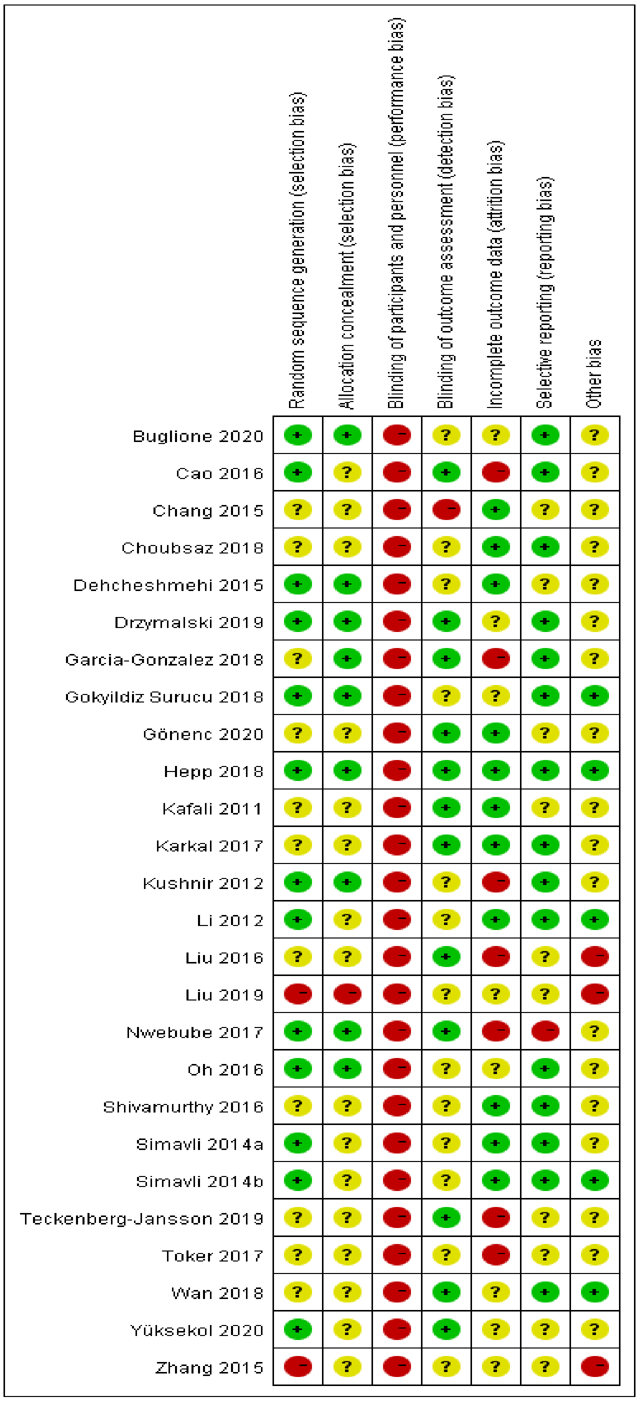

Figure 2(b): Risk of bias summary.

Among 26 RCTs, four studies reported the effects of music intervention on the outcome of depression. The pooled results also indicate that music interventions could significantly reduce depressive symptoms (SMD =-2.66, 95% CI: -4.98 to – 0.34) (Figure 4). The music interventions also tended to reduce women's stress, but without significantly statistical differences (SMD =-3.78, 95% CI: -7.79 to 0.24; Z=1.84, P =0.07) (Figure 5).

Eight studies reported the effects of music intervention on the physical outcomes of pain and blood pressure and pain. Figure 6 shows that music intervention could significantly reduce pain intensity (SMD =-1.43, 95% CI: -2.67 to – 0.18) (Figure 6), and blood pressure: systolic BP (SMD =-2.23, 95% CI: -3.76 to – 0.70), and diastolic BP (SMD =-1.80, 95% CI: -3.00 to –0.61) (Figure 7).

Four studies reported the effects of music intervention on women's heart rates, and found that music interventions significantly reduced heart rate vital signs (SMD =-3.33, 95% CI: -4.36 to -2.30) (Figure 8).

Five studies reported the effects of music interventions on women's childbirth satisfaction and quality of life, and found that music interventions significantly improved these outcomes (SMD =2.86, 95% CI: 1.66 to 4.05) (Figure 9).

Effects of Music Intervention on Child Outcomes

Music interventions were also found to positively improve fetal health outcomes. This meta-analysis found that music interventions positively stimulated fetal movement (SMD =1.62, 95% CI: 0.05 to 3.19) and accelerations (SMD =1.08, 95% CI: 0.74 to 1.42) (Figure 10).

Effects of Music Intervention on Maternal Outcomes Compared with Active Controls

Compared with other active controls (dance, massage or acupressure), music interventions exerted no significant effects on reducing women's health outcomes of anxiety (Z=0.13, P =0.90) (Figure 11), pain (Z=1.72, P =0.08) (Figure 12) or improved childbirth satisfaction (Z=0.87, P =0.38) (Figure 13).

Finally, funnel plot (Figure 14) appears relatively symmetrical indicating relatively insignificant publication bias, but meta-regression is required to identify any potential publication bias.

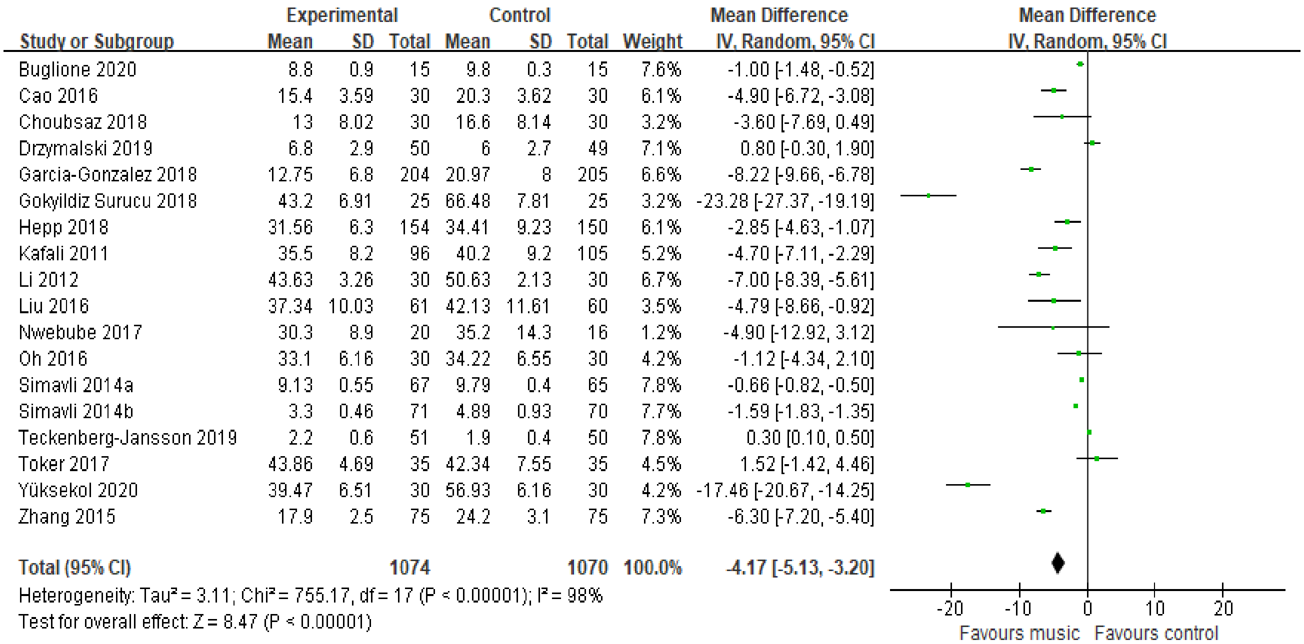

Figure 3: Effects of music interventions on anxiety symptoms.

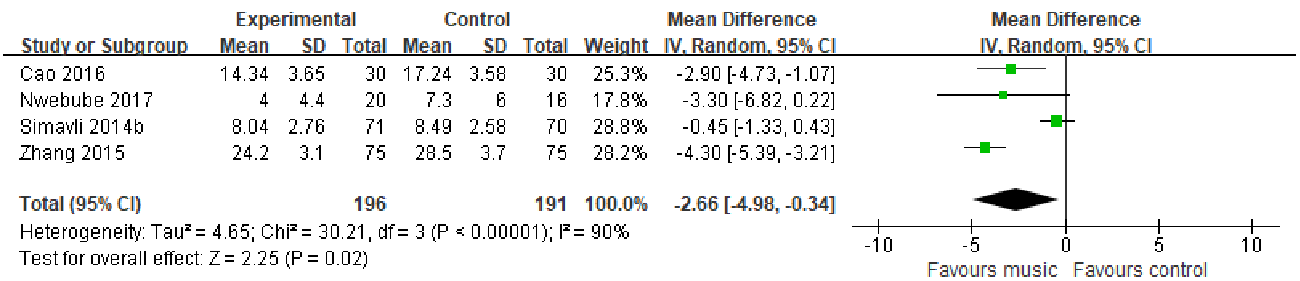

Figure 4: Effects of music interventions on depressive symptoms.

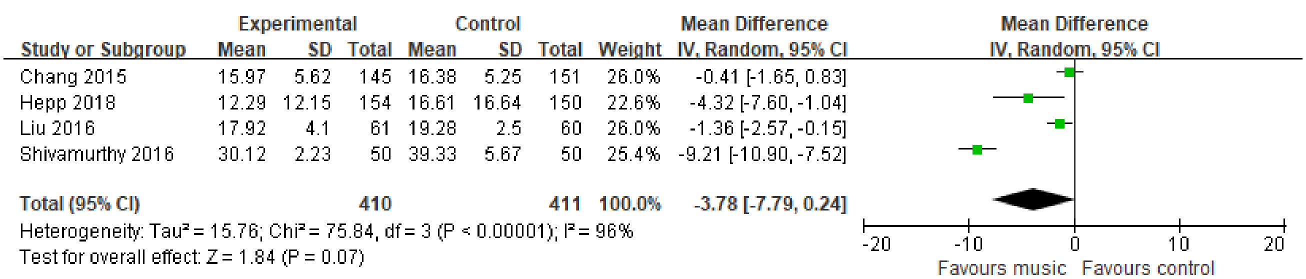

Figure 5: Effects of music interventions on stress.

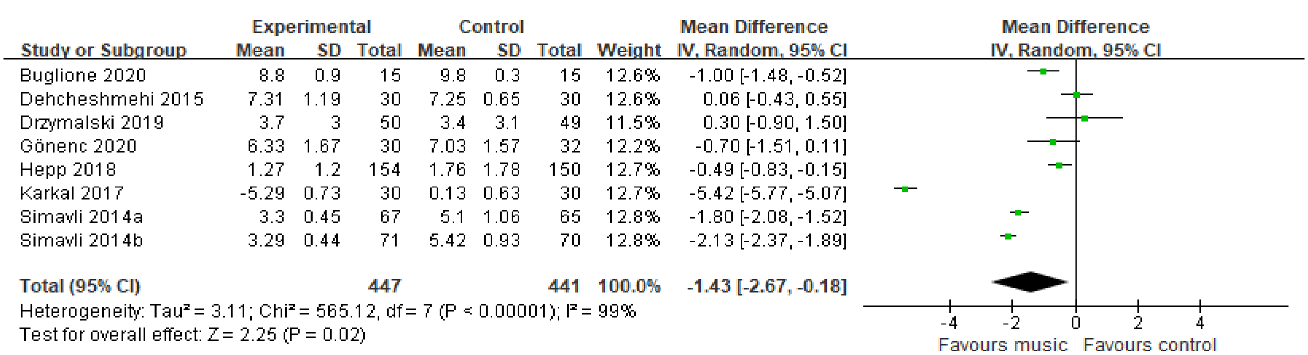

Figure 6: Effects of music interventions on pain intensity.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
1.6.1 Systolic BP								
Cao 2016	131.5	12.16	30	148.32	12.18	30	2.3%	-16.82 [-22.98, -10.66]
Drzymalski 2019	109	12	50	109	14	49	3.4%	0.00 [-5.14, 5.14]
Gokyildiz Surucu 2018	112.4	4.36	25	109.6	6.76	25	8.9%	2.80 [-0.35, 5.95]
Hepp 2018	121.42	12.89	154	121.58	13	150	10.5%	-0.16 [-3.07, 2.75]
Kushnir 2012	118.54	12.06	28	126.38	17.02	32	1.6%	-7.84 [-15.24, -0.44]
Oh 2016	103.97	8.2	30	104.13	8.35	30	5.0%	-0.16 [-4.35, 4.03]
Toker 2017	128.74	11.24	35	129.46	11.79	35	3.0%	-0.72 [-6.12, 4.68]
Yüksekol 2020	116.2	10.85	30	132.83	9.97	30	3.2%	-16.63 [-21.90, -11.36]
Subtotal (95% CI)			**382**			**381**	**37.9%**	**-2.23 [-3.76, -0.70]**
Heterogeneity: Chi² = 66.10, df = 7 (P < 0.00001); I² = 89%								
Test for overall effect: Z = 2.86 (P = 0.004)								
1.6.2 Diastolic BP								
Cao 2016	81.6	11.41	30	92.64	12.2	30	2.5%	-11.04 [-17.02, -5.06]
Drzymalski 2019	61	7	50	62	9	49	8.8%	-1.00 [-4.18, 2.18]
Gokyildiz Surucu 2018	72.4	4.36	25	70.4	7.35	25	7.9%	2.00 [-1.35, 5.35]
Hepp 2018	64.65	9.61	154	64.99	9.21	150	19.8%	-0.34 [-2.46, 1.78]
Kushnir 2012	72.89	9.21	28	79.53	10.92	32	3.4%	-6.64 [-11.73, -1.55]
Oh 2016	66.38	7.78	30	66.9	8.27	30	5.4%	-0.52 [-4.58, 3.54]
Toker 2017	80	6.68	35	83.09	7.75	35	7.7%	-3.09 [-6.48, 0.30]
Yüksekol 2020	78.33	6.86	30	83.67	7.53	30	6.7%	-5.34 [-8.99, -1.69]
Subtotal (95% CI)			**382**			**381**	**62.1%**	**-1.80 [-3.00, -0.61]**
Heterogeneity: Chi² = 24.22, df = 7 (P = 0.001); I² = 71%								
Test for overall effect: Z = 2.96 (P = 0.003)								
Total (95% CI)			**764**			**762**	**100.0%**	**-1.97 [-2.91, -1.02]**
Heterogeneity: Chi² = 90.51, df = 15 (P < 0.00001); I² = 83%								
Test for overall effect: Z = 4.09 (P < 0.0001)								
Test for subgroup differences: Chi² = 0.19, df = 1 (P = 0.67), I² = 0%								

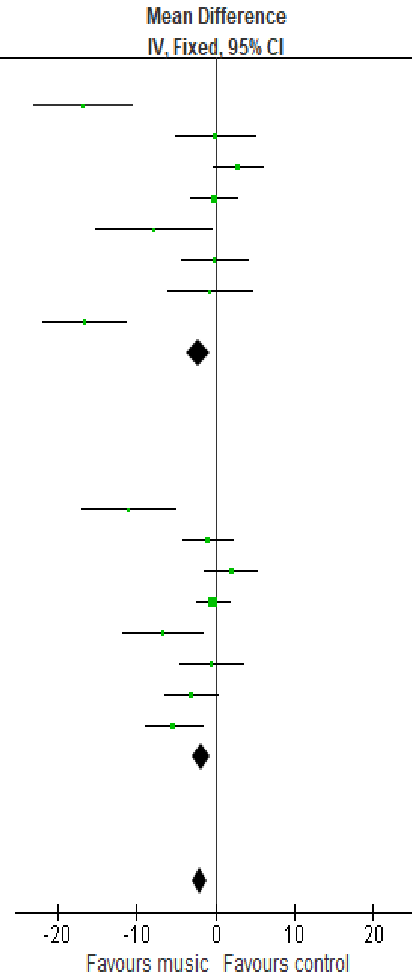

Figure 7: Effects of music interventions on blood pressure.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Fixed, 95% CI
Gokyildiz Surucu 2018	75.2	2.45	25	77.68	2.81	25	49.7%	-2.48 [-3.94, -1.02]
Hepp 2018	77.97	13.91	154	80.51	14.23	150	10.6%	-2.54 [-5.70, 0.62]
Kushnir 2012	80.57	7.62	28	86.44	6.71	32	7.9%	-5.87 [-9.53, -2.21]
Simavli 2014a	74.37	4.9	67	78.65	5.76	65	31.8%	-4.28 [-6.11, -2.45]
Total (95% CI)			**274**			**272**	**100.0%**	**-3.33 [-4.36, -2.30]**
Heterogeneity: Chi² = 4.43, df = 3 (P = 0.22); I² = 32%								
Test for overall effect: Z = 6.33 (P < 0.00001)								

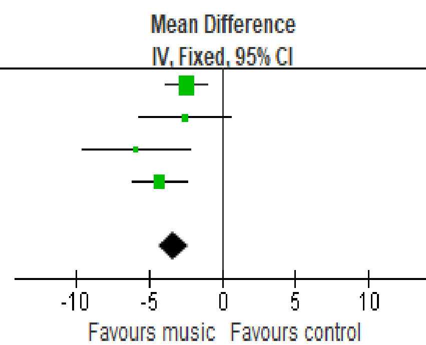

Figure 8: Effects of music interventions on heart rates.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Cao 2016	84.2	11.2	30	70.5	11.9	30	3.7%	13.70 [7.85, 19.55]
Kushnir 2012	4.55	0.87	28	3.51	0.98	32	30.9%	1.04 [0.57, 1.51]
Simavli 2014b	9.69	0.27	71	6.77	1.05	70	32.0%	2.92 [2.67, 3.17]
Toker 2017	86.54	10.42	35	74.62	21.78	35	2.1%	11.92 [3.92, 19.92]
Wan 2018	8.2	1.3	60	5.5	1	59	31.3%	2.70 [2.28, 3.12]
Total (95% CI)			**224**			**226**	**100.0%**	**2.86 [1.66, 4.05]**
Heterogeneity: Tau² = 1.15; Chi² = 67.86, df = 4 (P < 0.00001); I² = 94%								
Test for overall effect: Z = 4.68 (P < 0.00001)								

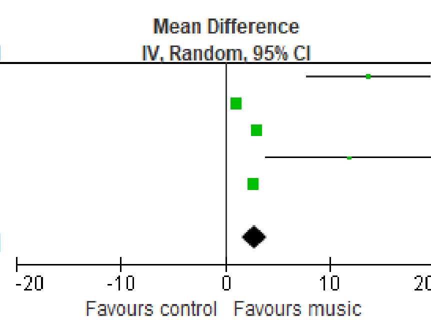

Figure 9: Effects of music interventions on overall satisfaction and QOL.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
1.9.1 Fetal heart rate								
Gokyildiz Surucu 2018	139.6	6.76	25	137.04	7.74	25	2.3%	2.56 [-1.47, 6.59]
Kafali 2011	134.09	7.2	96	130.3	5.7	105	7.7%	3.79 [1.98, 5.60]
Oh 2016	138.43	7.98	30	140.33	8.35	30	2.2%	-1.90 [-6.03, 2.23]
Simavli 2014a	135.97	8.93	67	131.23	7.07	65	4.4%	4.74 [2.00, 7.48]
Toker 2017	141.26	7.27	35	141.34	6.6	35	3.4%	-0.08 [-3.33, 3.17]
Subtotal (95% CI)			**253**			**260**	**20.0%**	**2.17 [-0.08, 4.41]**
Heterogeneity: Tau² = 4.01; Chi² = 11.07, df = 4 (P = 0.03); I² = 64%								
Test for overall effect: Z = 1.89 (P = 0.06)								
1.9.2 Fetal movement								
Kafali 2011	8.9	4.7	96	5.9	3.9	105	11.3%	3.00 [1.80, 4.20]
Oh 2016	12.95	8.87	30	11.4	8.29	30	2.1%	1.55 [-2.79, 5.89]
Simavli 2014a	5.22	1.35	67	4.83	1.14	65	16.7%	0.39 [-0.04, 0.82]
Toker 2017	5.43	3.93	35	3.72	1.62	35	9.9%	1.71 [0.30, 3.12]
Subtotal (95% CI)			**228**			**235**	**39.9%**	**1.62 [0.05, 3.19]**
Heterogeneity: Tau² = 1.82; Chi² = 18.16, df = 3 (P = 0.0004); I² = 83%								
Test for overall effect: Z = 2.02 (P = 0.04)								
1.9.3 Accelerations								
Kafali 2011	5.7	2.1	96	4.5	2.7	105	15.1%	1.20 [0.53, 1.87]
Oh 2016	7.08	3.45	30	5.95	3.23	30	8.3%	1.13 [-0.56, 2.82]
Simavli 2014a	5.54	1.63	67	4.51	0.5	65	16.7%	1.03 [0.62, 1.44]
Subtotal (95% CI)			**193**			**200**	**40.1%**	**1.08 [0.74, 1.42]**
Heterogeneity: Tau² = 0.00; Chi² = 0.19, df = 2 (P = 0.91); I² = 0%								
Test for overall effect: Z = 6.20 (P < 0.00001)								
Total (95% CI)			**674**			**695**	**100.0%**	**1.56 [0.90, 2.23]**
Heterogeneity: Tau² = 0.64; Chi² = 39.16, df = 11 (P < 0.0001); I² = 72%								
Test for overall effect: Z = 4.63 (P < 0.00001)								
Test for subgroup differences: Chi² = 1.28, df = 2 (P = 0.53), I² = 0%								

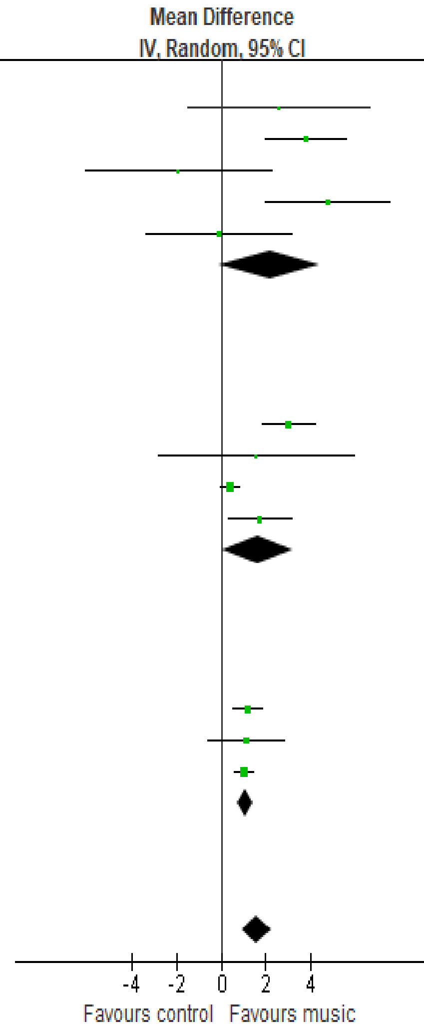

Figure 10: Effects of music interventions on child outcomes.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Choubsaz 2018	13	8.02	30	20.17	10.38	30	48.1%	-7.17 [-11.86, -2.48]
Liu 2019	35.85	4.06	485	30.74	3.95	488	51.9%	5.11 [4.61, 5.61]
Total (95% CI)			**515**			**518**	**100.0%**	**-0.80 [-12.82, 11.23]**
Heterogeneity: Tau² = 72.50; Chi² = 25.99, df = 1 (P < 0.00001); I² = 96%								
Test for overall effect: Z = 0.13 (P = 0.90)								

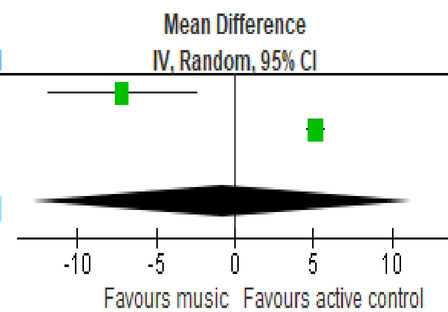

Figure 11: Effects of music interventions on anxiety compared with active controls.

Study or Subgroup	Experimental Mean	Experimental SD	Experimental Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Dehcheshmehi 2015	7.31	1.19	30	7.25	0.65	30	34.9%	0.06 [-0.43, 0.55]
Gönenc 2020	6.33	1.67	30	5	2.34	31	28.4%	1.33 [0.31, 2.35]
Liu 2019	7.72	2.1	485	6.17	1.94	488	36.7%	1.55 [1.30, 1.80]
Total (95% CI)			**545**			**549**	**100.0%**	**0.97 [-0.13, 2.07]**
Heterogeneity: Tau² = 0.84; Chi² = 28.47, df = 2 (P < 0.00001); I² = 93%								
Test for overall effect: Z = 1.72 (P = 0.08)								

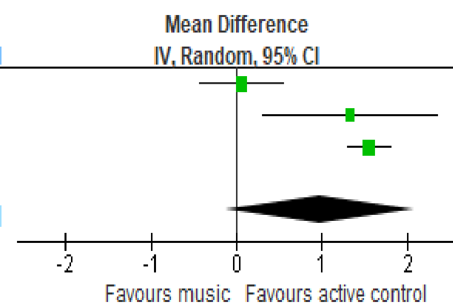

Figure 12: Effects of music interventions on pain intensity compared with active controls.

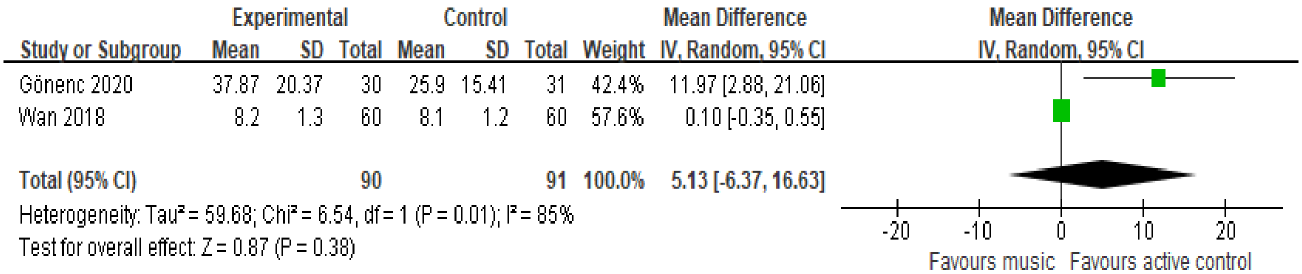

Figure 13: Effects of music interventions on satisfaction compared with active controls.

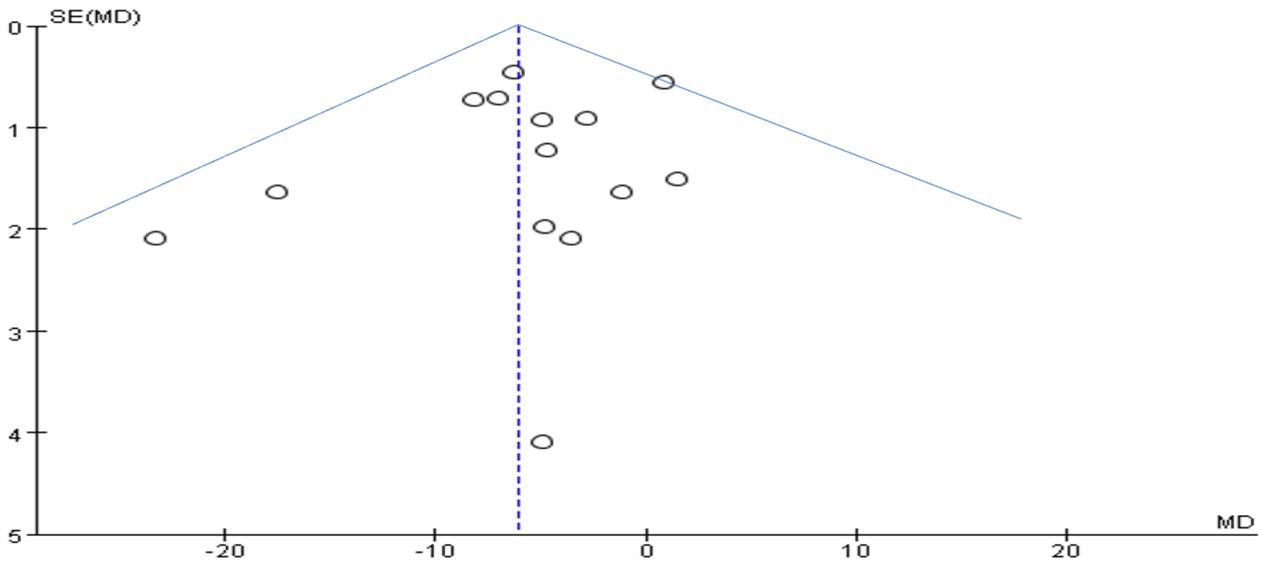

Figure 14: Funnel plot of the effect of music intervention on anxiety scores.

DISCUSSION

Summary of Main Results

Twenty-six RCTs involving 3,969 women in this updated systematic review suggest that current evidence indicates the benefits of music intervention on both maternal and child outcomes. Stress, anxiety and depression are very common in obstetric patients [1,2,4]. For this reason, numerous studies show that musical interventions are widely used to reduce anxiety, depressive symptoms and stress levels in these patients. In this updated meta-analysis, our study found that the use of musical interventions significantly reduced the maternal mental health problems of anxiety, depressive symptoms and stress, in comparison with the usual care group. In addition, musical interventions significantly reduced the pain intensity of women during labor and also reduced blood pressure. Moreover, this meta-analysis found that musical intervention has positive effects on fetal vital signs, such as fetal heart rate, fetal movement and accelerations. Compared with other active controls such as dance, massage and acupressure, musical interventions had no significant effects on reducing maternal anxiety and pain intensity levels, or increasing overall childbirth satisfaction.

Similarities or Differences with other Studies or Reviews

This updated review is consistent with previous systematic reviews related to the effects of musical intervention on lowering anxiety and pain intensity in study participants during labor [3.10.19]. Additionally, this meta-analysis found a significant decrease in the vital signs of heart rate, SBP and DBP after musical intervention, which is consistent with Lin et al. [10]. Musical intervention reduces the objective parameters of HR and BP, which supports the positive findings of the effects of musical intervention on the subjective parameters of stress and anxiety [49]. The mechanism of music has the potential to change the physiological indications of pain. HR and BP are based on the psychophysiological theory [50]. The anxiolytic effect of music may be achieved by activating the release of endorphins, suppressing sympathetic nervous system activity, decreasing cortisol levels, and triggering activity in specific brain regions linked to emotion, modulating anxiety levels [51-53]. However, this review differs from previous systematic reviews analyzing the effect of musical intervention on women during pregnancy [1,2]. These reviews analyzed anxiety and stress levels in only a few RCTs (fewer than 10), until 2015. This updated review involved 26 RCTs and used mostly recent studies (18 within the past five years).

Study Limitations

Certainly, this meta-analysis has several limitations. While this updated review indicates that music interventions can reduce pain intensity and the vital signs of heart rate, blood pressure and mental health problems of women during pregnancy, childbirth and postpartum, the moderate to weak methodological quality suggests the results should be interpreted with caution. Due to the nature of the interventions, although subjects could not be blinded, most of the trials that were included did not provide details on whether they blinded the outcome assessors or not, reducing the validity of the study findings. Last but not least, this meta-analysis did not conduct a subgroup analysis based on the music intervention type, intervention duration or outcome measurement time. Therefore, future well-designed studies are required, to establish solid guidelines for musical interventions in obstetric practice, based on robust clinical trials [54].

CONCLUSION

This updated review and meta-analysis provides evidence that musical interventions during pregnancy may have beneficial effects on perinatal mental health problems such as anxiety, depression, stress, the physiological indexes of pain, heart rate, SBP, DBP and childbirth satisfaction. In addition, musical interventions also exert positive effects on the outcomes of fetal heart rate, fetal movement and accelerations.

Implications for Research

This updated review found that the frequency and the total duration of musical interventions varied widely, with some studies adopting a single session and other studies conducting multiple sessions. Thus, future research needs to establish the optimal dosage of music interventions for women in an obstetric setting. Consistent with existing systematic reviews of using music to treat pregnant women [1,4], there was weak methodological quality in most of the trials that were included. Hence, methodologically strong randomized controlled trials will be required when conducting further research in this area. More rigorous trials, with limited risk of bias, should be adequately powered. Finally, there is limited data available to assess the effects of music interventions, compared to other active controls with a longer follow-up. Future research should consider long-term assessment of the effects of musical interventions on women and child outcomes, compared with other types of CAM interventions.

Clinical Implications

Overall, there is a relatively high prevalence of mental health problems among women in both the antenatal and postnatal periods. There is also high comorbidity between anxiety and depression, as pregnant women who reported having anxiety may also report having depressive symptoms [55]. Pregnant women who experience antenatal anxiety will be more likely to suffer long-term mental health problems in the postnatal period [56]. Hence, early identification and treatment of maternal mental health problems may help to reduce a child's risk for adverse outcomes, thus achieving better maternal and child health and well-being [1]. From this updated systematic review, there is consistent evidence informing clinical practice that music-based interventions may have the potential to reduce obstetrical complications. Application of musical interventions across the three trimesters and during labor may be advisable in routine obstetric practice.

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